Adaptive Curvilinear Coordinates in a Plane-Wave Solution of Maxwell's Equations in Photonic Crystal Fibre

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A method is described to compute the modes propagating at a given frequency in photonic crystal fibres (PCFs), using a plane-wave basis expressed in a system of generalised curvilinear coordinates. The coordinates are adapted to the structure under consideration by increasing the effective plane-wave cutoff in the vicinity of the interfaces between dielectrics, where the electromagnetic fields vary most rapidly. This amounts to representing the dielectric function and magnetic field on a real-space grid of the form of that in Fig. 1. In practice, calculations are performed in another space, where grids are uniform so that all advantages of plane-wave methods hold—in particular the use of FFTs [1].

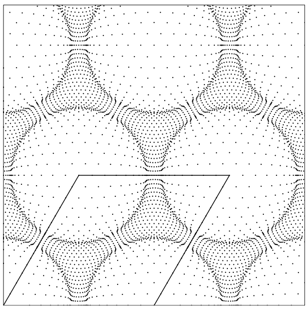

Fig. 1: Real-space sampling grid for a typical PCF cladding structure of air holes in glass.

We demonstrate the favourable efficiency and convergence properties of the method by comparison with the conventional plane-wave formulation of Maxwell's equations. Although the method is developed to study propagation in photonic crystal fibres, it is also applicable more generally to plane-wave modal solutions of structured dielectrics.

[1] F. Gygi, Phys. Rev. B **48**, 11692 (1993).